POWDERMET INC.

The Cutting Edge in Metal Powder Technology

PComP™: Nano-Composite Thermal Spray Alternative to Cd and Cr

SERDP/ESTCP Workshop
Tempe, AZ

February 26-28, 2008

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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	**FEB 2008**
2. REPORT TYPE	
3. DATES COVERED	**00-00-2008 to 00-00-2008**
4. TITLE AND SUBTITLE	**PComPtm: Nano-Composite Thermal Spray Alternative to Cd and Cr**
5a. CONTRACT NUMBER	
5b. GRANT NUMBER	
5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)	
5d. PROJECT NUMBER	
5e. TASK NUMBER	
5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	**Powdermet Inc,24112 Rockwell Dr,Euclid,OH,44117**
8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	
10. SPONSOR/MONITOR'S ACRONYM(S)	
11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT	**Approved for public release; distribution unlimited**
13. SUPPLEMENTARY NOTES	**Surface Finishing and Repair Issues for Sustaining New Military Aircraft Workshop, February 26-28, 2008, Tempe, AZ. Sponsored by SERDP/ESTCP.**
14. ABSTRACT	
15. SUBJECT TERMS	

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**18**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

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Acknowledgments

- EPA Phase I SBIR CONTRACT # EP-D-06-053
  - *Metastructured Cermets for Hard Chrome Replacement*
- Ohio Third Fronter Grant ORCGP-04-063
  - *Commercialization of MicroComposite Powders*
- NASA SBIR Grant NNC07QA06P
  - *Erosion Resistant Compressor Blade Repair Technologies*
- National Science Foundation 637502
- Boeing –Fatigue testing and data
- PTI –HVOF Coating Services

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Outline

- Introduction to Powdermet
- Hierarchically Structured Materials
- PComP™
- Work Plan
- Testing
- Conclusion

Powdermet

- Application Driven Powder Development Company
- Specializing in Powder Modification
  - Particle Size Engineering
    - Bottom up/Top Down
  - Compositing
  - Agglomeration
  - Particle Coating
- Develop Powders to Meet Specification

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Microcomposite coating Materials Approach

- Combine hardness of lightweight ceramic with ductility and toughness of metal
  - Start with low cost, lightweight ceramic (Al2O3 or SiC, -Si3N4 for low friction). 3-4g/cc, 0.1-1 micron particle size
  - Blend and Spray-dry with corrosion resistant ductile metal alloy binder (Ni baseline)
    - Keep structure nanocrystalline, high hardness, corrosion resistance, and strength
  - Encapsulate with additional matrix for toughness/ductility
    - Micron-scale “lamella” in coating to allow for dislocation motion (ductility)
  - Thermal spray to form ductile wear and corrosion resistant coatings.
    - Laser fuse, cold-spray alternatives
  - Patent-pending materials technology

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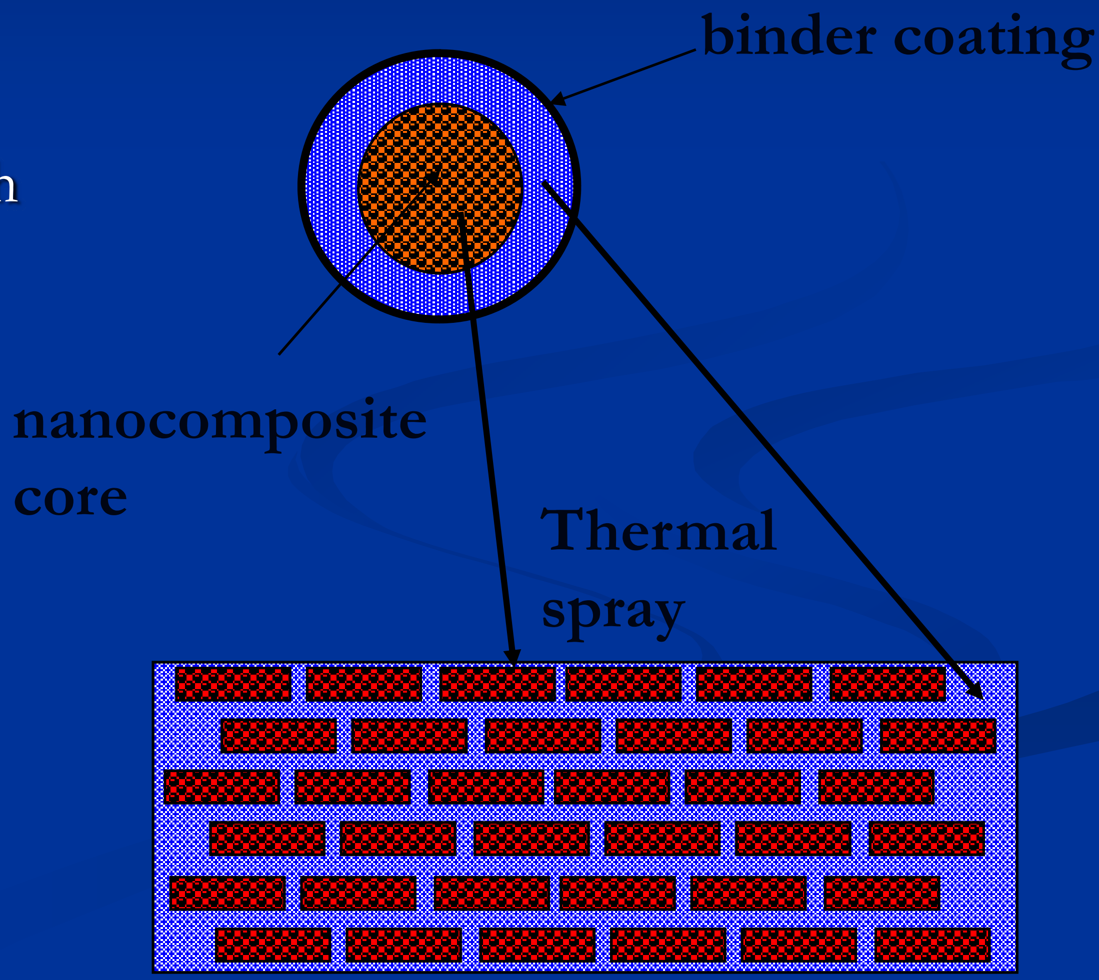
The Micro/Nanocomposite solution

- nanocomposite provides high wear resistance, low friction
- Ductile binder provides ductility and toughness
- Working on HVOF, laser cladding, cold spray, and spray and fuse powder designs



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Microcomposite coating features

	Micro-Composite Coatings	Chrome Plate	WC-Co-Cr thermal spray
Coating density	**4-5g/cc (low)**	9g/cc (medium)	17g/cc (very high)
Total coating cost	**Less than 1X**	Baseline (1X)	2X
modulus	**20-30MSI**	0 (cracked)	65 MSI
Gun throughput	**>3X**	Days to coat	1X
Surface finishing costs	**SiC or alumina wheel**	Alumina wheel	Diamond wheel
Ductility	**4%**	<0% (cracked)	<1%
Wear Performance	**10X chrome**	1X chrome	3X chrome
Thickness limitations	**>40 mils**	3-5 mils	10-20 mils

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PComP ™

- Drop-In Replacement for Thermal Spray Materials
- Reduced Density (3.5-6.5 g/cm^3)
- Doesn't Require Special Tooling
  - No Diamond/CBN Grinding
- Low-
  - Density, Friction, Stiffness

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PComP ™ Materials

- WC-Co
  - Applied by PTI
  - Tested by Boeing
- Core Reinforcements
  - TiN, Si_3N_4, TiC, Al_2O_3
- Metal Binders
  - Ni, Ni-Cr, Ni-Cr-Mo

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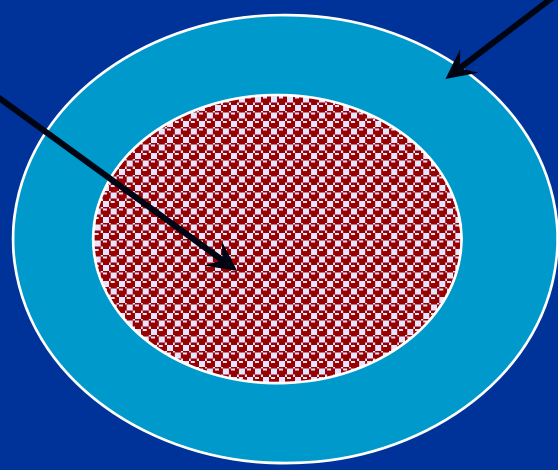
Powder design variables

Coating: composition, thickness

Core: diameter, density, grain size, pore size, metal/ceramic V%



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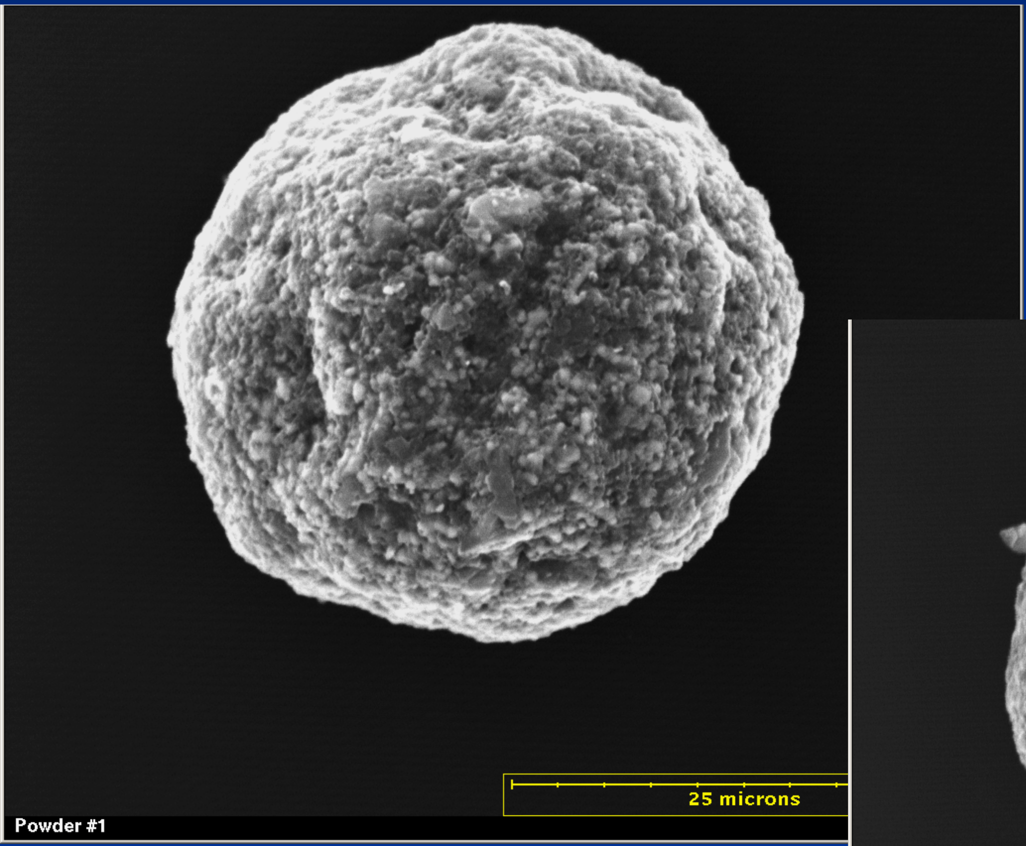
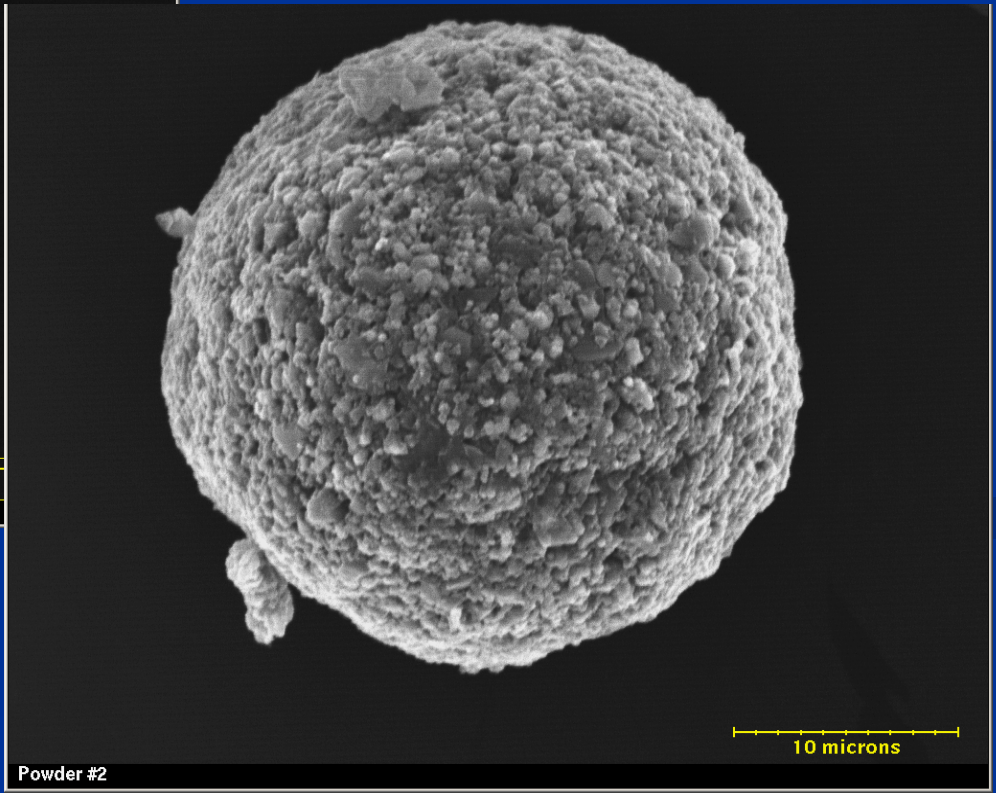
Nanocomposite Powders Developed





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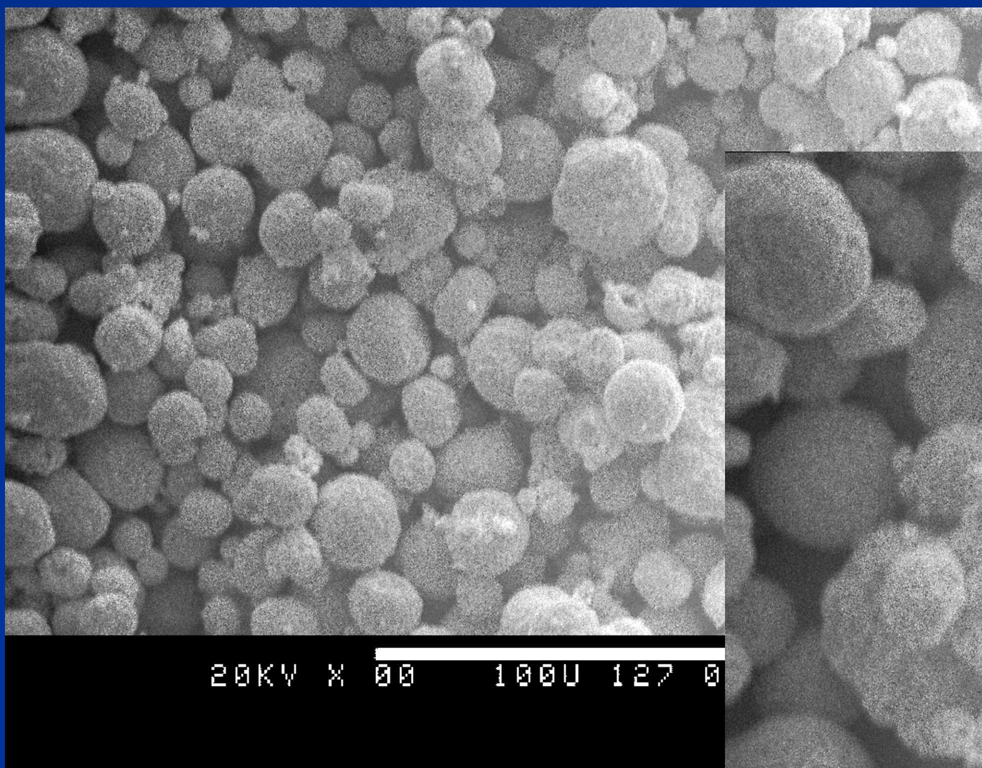
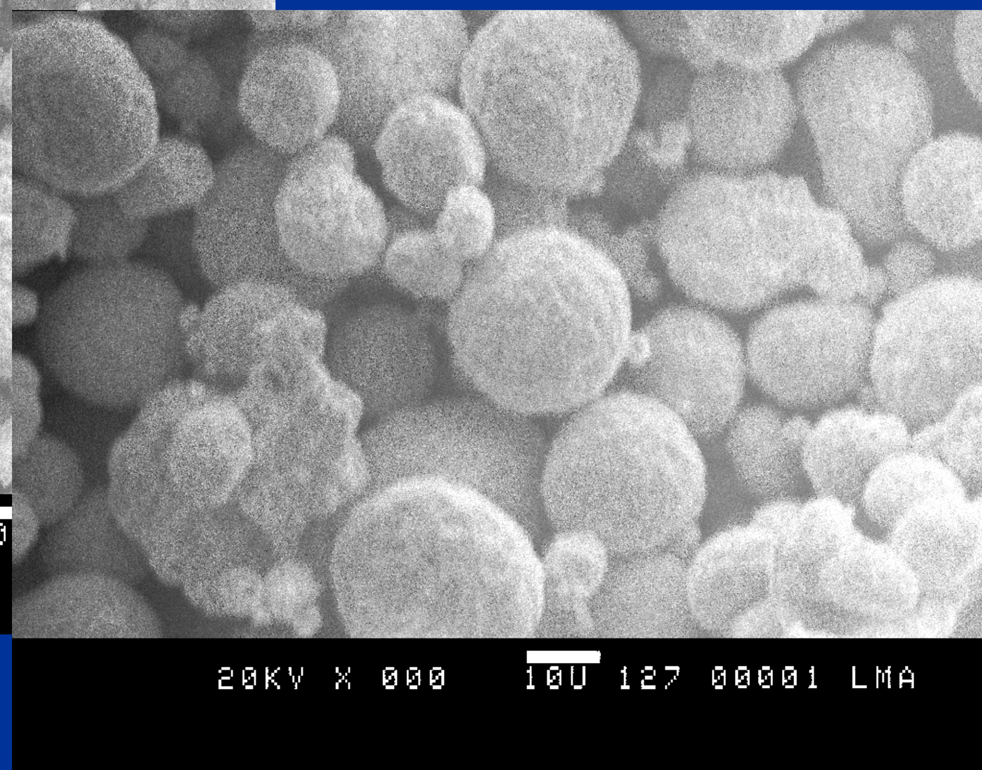
DJ- Cut, HVOF powders





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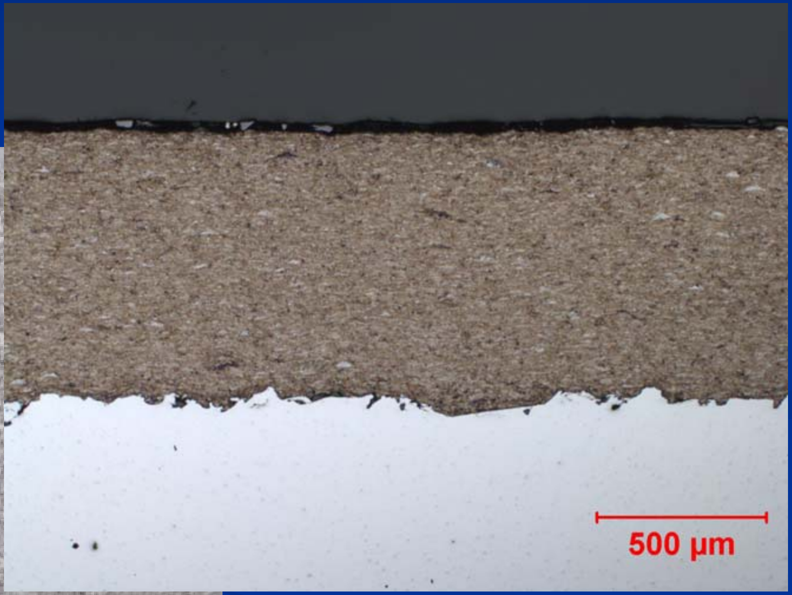
Composite Structure



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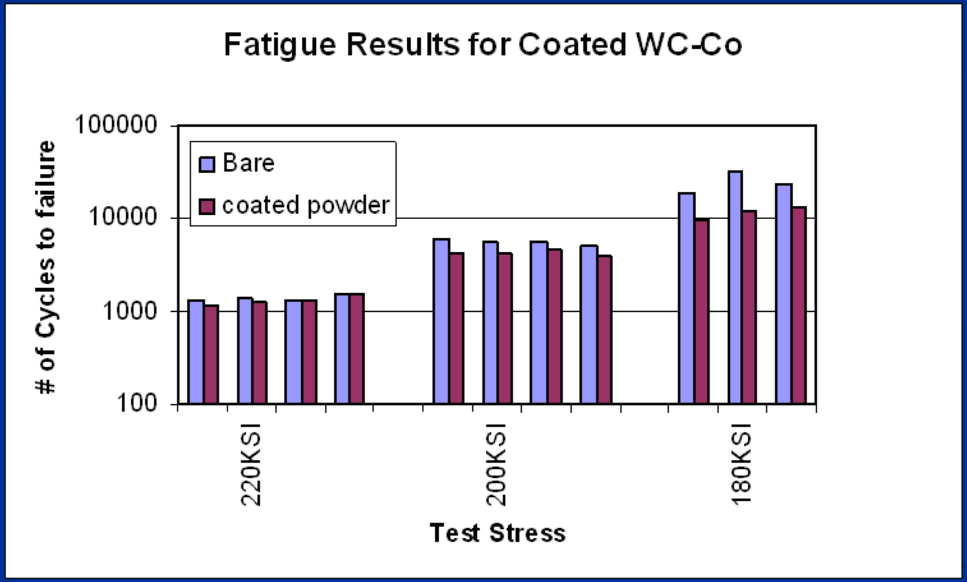
Fatigue life for bare and coated samples at different test stress conditions



Axial tension-compression fatigue (R= -1.0), in room temperature air, at 2 Hz. Fatigue specimens were cylindrical bar 8 inches long, 0.75 inches in diameter, with an hourglass shape narrowing to a minimum of 0.3 inches. The fatigue debit as a result of coating is less than a factor of 2.

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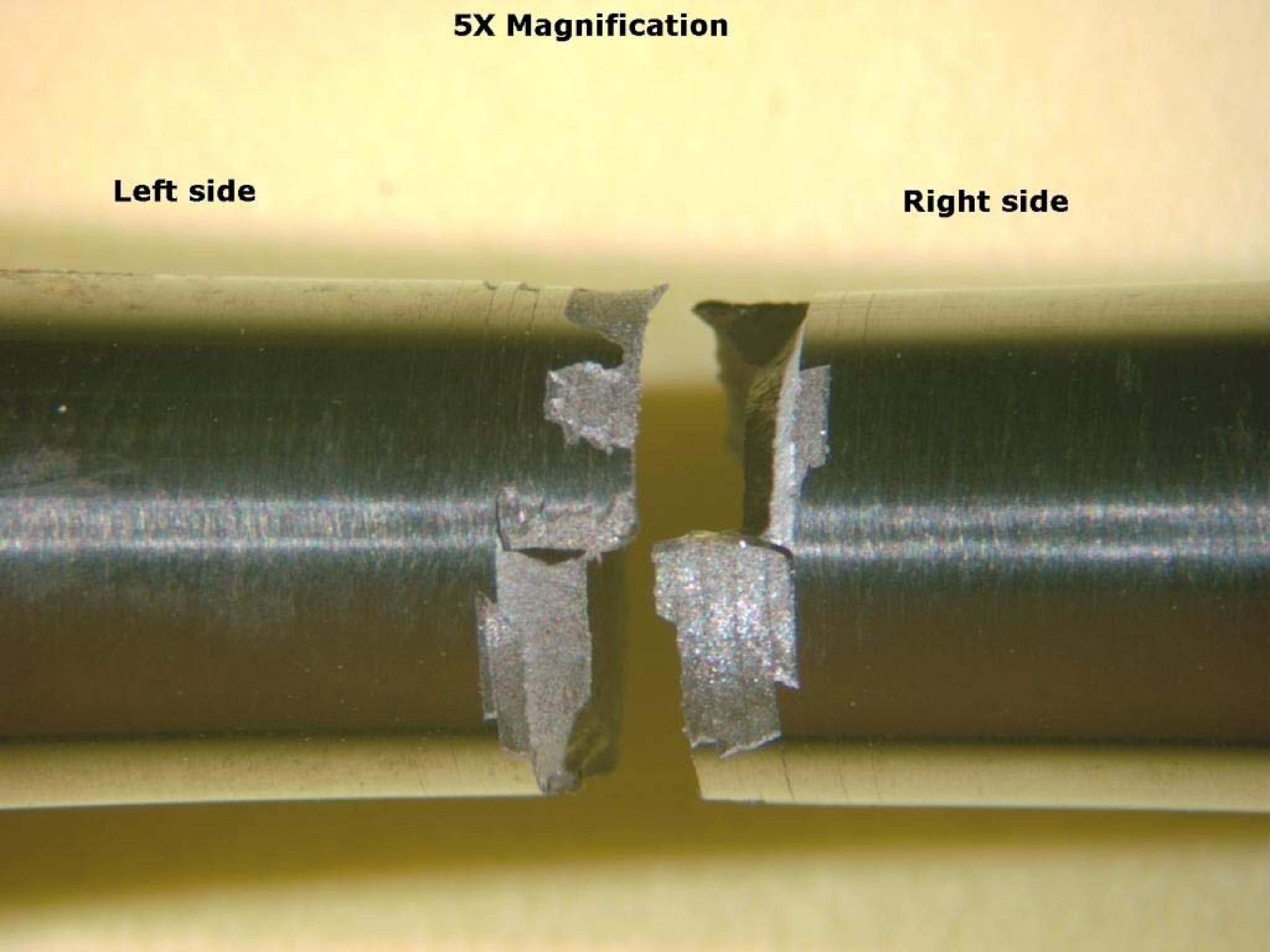
Fatigue Data Observations: Notes from Test Operator

Specimen Number	Cycles to Failure	Notes
7604-10 C	**2,120**	**No spalling before failure**
7604-12 C	2,129	Crack in coating at 750 cycles. Spalling at 1500 cycles.
7604-13 C	2,258	No spalling before failure
7604-14 C	1,949	No spalling before failure


5X Magnification
Left side
Right side

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Closing

- Hierarchically Structured Coatings Offer Numerous Advantages
- PComP™ Improves on Meso-Structured Composite Materials
- PComP™ Can Meet Rigorous Landing Gear Requirements (AF/Navy/Civilian)
- Need Specifications for Materials Design

QUESTIONS?

COMMENTS